PATENT ABSTRACTS OF JAPAN

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(54) LEAD FREE SOLDER

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain an alloy superior in heat cycle resistance and mechanical strength by adding a given volume of Bi and In into a Sn alloy containing a given volume of Cu.

SOLUTION: One or more kinds of 1-15 wt.% Bi and 1-15 wt.% In are added into an alloy composed of 0.1-2.5 wt.% Cu and the balance of Sn. Furthermore, it is preferable that one or more kinds of Ni, Ge, Pb, Au, Ti and Fe are added to the alloy at 0.01-2 wt.%. This solder alloy does not contain lead at all, but is superior in heat cycle resistance and mechanical strength. Bi and In are individually or simultaneously added in order to lower the melting point of a Sn-Cu base solder alloy, whereby the solder alloy with less thermal damage against electronic parts during soldering is obtained. Crystals of the solder alloy are fined due to addition of Ni and Ge, and a compound between Sn, Cu and metal is created due to addition of Pd, Au, Ti and Fe. This prevents slippage in a grain boundary, so as to improve a mechanical strength.

LEGAL STATUS

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0.01 – 2 % Fe
0.1 - 2.5 % Cu
Sn

rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

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CLAIMS

[Claim(s)]
[Claim 1] A Bi and lead [which is characterized by adding one or more sorts of In one to 15% of the weight] free [one to 15% of the weight]-in alloy which consists of Cu and the remainder Sn 0.1 to 2.5% of the weight solder.
[Claim 2] A Bi and lead [which is characterized by adding one or more sorts further chosen from nickel, germanium, Pd, Au, Ti, and Fe into this alloy 0.01 to 2% of the weight while one or more sorts of In are added one to 15% of the weight] free [one to 15% of the weight]-in alloy which consists of Cu and the remainder Sn 0.1 to 2.5% of the weight solder.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention does not contain lead at all, but relates to the solder which was moreover excellent in heat-resistant cycle nature or a mechanical strength.
[0002]
[Description of the Prior Art] As a solder used for soldering of electronic equipment, a Sn-Pb alloy is common and had been used more from ancient times for a long time. The melting point of an eutectic presentation (63 Sn-Pb) calls a Sn-Pb alloy 183 degrees C, and it is the temperature which does not do heat damage to the heat of [low] 230-240 degrees C in the soldering temperature to weak electronic parts. And while a Sn-Pb alloy has very good soldering nature, there is no temperature gradient between liquidus-line temperature and solidus-line temperature, and it solidifies immediately at the time of soldering, and has the outstanding features of causing neither a cracking crack nor exfoliation even if an oscillation and an impact join the soldering section.
[0003] Generally, when it broke down, or it becomes old and user-friendliness worsens, disposal of television, video, radio, a tape recorder, a computer, and electronic equipment like a copying machine is carried out. these electronic equipment -- synthetic resin [like plastics] whose outer frame and printed circuit board are -- it is -- moreover, a conductor -- since the section and a frame are metal, incineration disposal cannot be performed but most is buried in the earth.
[0004] By the way, the rain which a sulfur oxide is emitted to a large quantity by multiple use of petrifaction fuels, such as a gasoline and a fuel oil, into atmospheric air, consequently falls on the ground is acid rain in recent years. Acid rain carries out the elution of the solder of the electronic equipment buried in the earth, sinks in underground, and comes to pollute an underground water. Thus, if the underground water containing lead is drunk for years, a part for lead will be accumulated in the body and a possibility of starting **** will come out. From such opportunity, the so-called appearance of the solder which does not contain lead, and a "lead free solder" has been desired by the electronics.
[0005] There were Sn-Ag of Sn principal component, an alloy Sn-Cu alloy, and a Sn-Sb alloy as a lead free solder conventionally. The low presentation of melting temperature is [the melting temperature of a Sn-Ag alloy] 221 degrees C in the eutectic presentation of Sn-3.5Ag most. The soldering temperature of the solder of this presentation becomes in 260-280 degrees C, it is a high temperature, and if it solders at this temperature, weak electronic parts will cause functional deterioration, destruction, etc. in response to heat damage with heat. The melting temperature is 227 degrees C, and in a Sn-Ag alloy, soldering temperature will become the same highly too, and it will make electronic parts for the low presentation of melting temperature of a Sn-Cu alloy to be Sn-0.7Cu most, and start heat damage. Moreover, since it is a high temperature of [although the presentation lowest / of melting temperature / of a Sn-Sb alloy is Sn-5Sb / melting temperature / of this presentation / temperature / solidus-line] 240 degrees C in 235 degrees C and liquidus-line temperature, it becomes 280-300 degrees C with a soldering temperature still higher than an Sn-3.5Ag alloy and Sn-Cu alloy, and heat damage of the electronic parts too weak with heat is carried out.
[0006] Thus, since a Sn-Ag alloy, a Sn-Cu alloy, and a Sn-Sb alloy have high melting temperature, many solders which provided the means which lowers the melting temperature of these alloys are proposed. (Reference: JP,6-15476,A, a 6-344180 official report, a 7-1178 official report, 7-40079 official report)
[0007]
[Problem(s) to be Solved by the Invention] By the way, if electronic equipment leads current at the time of an activity, the Joule's heat will occur from components, such as a power transistor, resistance, and a coil, and the

inside of the case of electronic equipment will serve as an elevated temperature. And if energization is cut in order to stop the activity of electronic equipment, the inside of a case will be lowered from an elevated temperature to a room temperature. Thus, if it repeats an activity and un-using it, the inside of a case will be put to the heat cycle of repeating an elevated temperature and a room temperature. [of electronic equipment] Although this heat cycle also comes to attain to the soldering section, since a coefficient of thermal expansion is dramatically different, a solder is restrained by this thermal expansion and contraction, for years, within a month, it will cause the metal fatigue and, as for the printed circuit board made of the resin of the soldering section, and a metaled solder, ********** will destroy it at last. If the solder of the soldering section breaks, it stops energizing at all, will generate heat that not only malfunctioning and ** of electronic equipment but the soldering section is in a poor-contact condition by contact resistance, and will also become the cause of an outbreak of a fire. Therefore, a pile solder is increasingly asked for the metal fatigue in the soldering section by the lifting by the heat cycle recently.

[0008] The lead free solder which used Sn as the principal component excels the conventional Sn-Pb solder in heat-resistant cycle nature, and has the property which was excellent in reinforcement with the environmental problem of not using lead.

[0009]

[Problem(s) to be Solved by the Invention] However, although the Sn-Ag system solder and the Sn-Sb solder were excellent in heat-resistant cycle nature, they were not yet enough. Moreover, the mechanical strength the Sn-Cu system solder excelled [mechanical strength] in what serves as an important Safety Department article like a mounted substrate further although mechanical strengths were a Sn-Ag system solder, a Sn-Sb system solder, and an abbreviation EQC is required. This invention is to offer the lead free solder excellent in the mechanical strength while it is excellent in heat-resistant cycle nature.

[0010]

[Means for Solving the Problem] this invention person inquired wholeheartedly about how for a solder of a Sn-Cu system to be what noted having heat-resistant cycle nature compared with a Sn-Ag system solder or a solder of a Sn-Sb system, to lower the melting point of a Sn-Cu system solder, and to lessen heat damage to electronic parts at the time of soldering, and to raise [how] a mechanical strength of a Sn-Cu system solder, and completed this invention.

[0011] This invention in an alloy which consists of Cu and the remainder Sn 0.1 to 2.5% of the weight They are Bi and the lead free solder characterized by adding one or more sorts of In one to 15% of the weight one to 15% of the weight. Moreover, while one or more sorts of Bi and 1-15 % of the weight In are added one to 15% of the weight in an alloy which consists of Cu and the remainder Sn 0.1 to 2.5% of the weight It is the lead free solder characterized by adding one or more sorts furthermore chosen from nickel, germanium, Pd, Au, Ti, and Fe into this alloy 0.01 to 2% of the weight.

[0012]

[Embodiment of the Invention] In the solder used as Sn principal component excellent in heat-resistant cycle nature, Cu is an indispensable component. If there are few additions of Cu in this invention than 0.1 % of the weight, it will not contribute to heat-resistant cycle nature, however even if it adds the component which will lower melting temperature to others if it adds exceeding 2.5 % of the weight, liquidus-line temperature will not be able to be lowered, but soldering temperature will also become high, and it will be connected with the heat damage of electronic parts.

[0013] In this invention, in order to lower the melting point of a Sn-Cu system solder, Bi and In are added respectively independently or simultaneous. If there are few these additions than 1 % of the weight, the effect of lowering the melting point of a Sn-Cu system solder will not show up. However, if time amount will be taken before solidus-line temperature will fall extremely, the solidification range between liquidus-line temperature and solidus-line temperature will become very large and a solder will solidify thoroughly after soldering, if these additions increase more than 15 % of the weight, and an oscillation and an impact are added between them, a cracking crack and exfoliation will take place to the soldering section.

[0014] Moreover, in this invention, one or more sorts further chosen as the Sn-Cu system solder which added Bi and In from nickel, germanium, Pd, Au, Ti, Fe, etc. may be added. As for Pd, Au, Ti, and Fe, nickel and germanium make the crystal of a Sn-Cu system solder detailed, an effect is in the improvement in a mechanical strength, and Sn, and Cu and an intermetallic compound are generated, and this prevents slipping in the grain boundary and raises a mechanical strength too.

[0015]
[Example] The example and the example of a comparison of this invention are shown in a table 1.
[0016]
[A table 1]

		組成					耐熱サイクル	機械強度	溶融温度	
		Sn	Cu	Bi	In	その他	(回数)	(Kgf/cm²)	S. T	L. T
実施例	1	残	0.075	3			960	8.4	214	223
	2	残	0.5		7		1030	5.1	205	214
	3	残	0.5	6	3		1150	10.3	188	214
	4	残	1.0	2	6		1220	6.2	192	216
	5	残	0.7	5	5	Ge0.2	1300	9.2	185	213
	6	残	0.5	4	7	Ni0.2	1280	8.6	182	200
	7	残	1.0	5		Ge0.2	990	9.1	215	220
	8	残	0.6	4	4	Ge0.05 Ni0.1	1380	8.6	192	216
	9	残	0.5	6	3	Pd0.1	1200	10.5	188	214
	10	残	0.7	5	5	Au0.2	1320	9.6	185	213
	11	残	0.5	2	6	Ti0.05	1310	6.5	192	216
	12	残	0.6	4	7	Fe0.1	1330	8.9	182	200
比較例	1	残	1					4.2	227	238
	2	残				Pb37	780	6.1	183	183
	3	残				Ag4	860	4.7	221	235
	4	残		3	3	Ag4	940	8.4	201	219
	5	残	0.5	7.5		Ag2	820	10.8	194	217

[0017] The explanation O heatproof cycle of a table 1: Solder with the solder paste which produced the lead of QFP of a surface mounted device, and the land of a printed circuit board by the solder of each presentation, and measure a count until it bets a heat cycle between -55 degrees C and +125 degrees C and a crack produces this soldering section in the soldering section.
O Mechanical strength : it is based on the "metallic material test method" of JIS-Z -2204.
O Melting temperature : a differential thermal analyzer performs thermal analysis for various kinds of solders, and measure solidus-line temperature (S. T) and liquidus-line temperature (L. T).
[0018]
[Effect of the Invention] As explained above, it is the lead free solder of this invention, Although are excelled in heat-resistant cycle nature, and melting temperature can be high and doing heat damage to electronic parts at the

time of soldering can lower the melting temperature of this solder in the Sn-Cu system solder which was a defect, while raising heat-resistant cycle nature further, it has the outstanding property which is not in the conventional lead free solder that a mechanical strength can also be raised.

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TECHNICAL FIELD

[Industrial Application] This invention does not contain lead at all, but relates to the solder which was moreover excellent in heat-resistant cycle nature or a mechanical strength.

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PRIOR ART

[Description of the Prior Art] As a solder used for soldering of electronic equipment, a Sn-Pb alloy is common and had been used more from ancient times for a long time. The melting point of an eutectic presentation (63 Sn-Pb) calls a Sn-Pb alloy 183 degrees C, and it is the temperature which does not do heat damage to the heat of [low] 230-240 degrees C in the soldering temperature to weak electronic parts. And while a Sn-Pb alloy has very good soldering nature, there is no temperature gradient between liquidus-line temperature and solidus-line temperature, and it solidifies immediately at the time of soldering, and has the outstanding features of causing neither a cracking crack nor exfoliation even if an oscillation and an impact join the soldering section.
[0003] Generally, when it broke down, or it becomes old and user-friendliness worsens, disposal of television, video, radio, a tape recorder, a computer, and electronic equipment like a copying machine is carried out. these electronic equipment -- synthetic resin [like plastics] whose outer frame and printed circuit board are -- it is -- moreover, a conductor -- since the section and a frame are metal, incineration disposal cannot be performed but most is buried in the earth.
[0004] By the way, the rain which a sulfur oxide is emitted to a large quantity by multiple use of petrifaction fuels, such as a gasoline and a fuel oil, into atmospheric air, consequently falls on the ground is acid rain in recent years. Acid rain carries out the elution of the solder of the electronic equipment buried in the earth, sinks in underground, and comes to pollute an underground water. Thus, if the underground water containing lead is drunk for years, a part for lead will be accumulated in the body and a possibility of starting **** will come out. From such opportunity, the so-called appearance of the solder which does not contain lead, and a "lead free solder" has been desired by the electronics.
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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] By the way, if electronic equipment leads current at the time of an activity, the Joule's heat will occur from components, such as a power transistor, resistance, and a coil, and the inside of the case of electronic equipment will serve as an elevated temperature. And if energization is cut in order to stop the activity of electronic equipment, the inside of a case will be lowered from an elevated temperature to a room temperature. Thus, if it repeats an activity and un-using it, the inside of a case will be put to the heat cycle of repeating an elevated temperature and a room temperature. [of electronic equipment] Although this heat cycle also comes to attain to the soldering section, since a coefficient of thermal expansion is dramatically different, a solder is restrained by this thermal expansion and contraction, for years, within a month, it will cause the metal fatigue and, as for the printed circuit board made of the resin of the soldering section, and a metaled solder, ********** will destroy it at last. If the solder of the soldering section breaks, it stops energizing at all, will generate heat that not only malfunctioning and ** of electronic equipment but the soldering section is in a poor-contact condition by contact resistance, and will also become the cause of an outbreak of a fire. Therefore, a pile solder is increasingly asked for the metal fatigue in the soldering section by the lifting by the heat cycle recently.
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MEANS

[Means for Solving the Problem] this invention person inquired wholeheartedly about how for a solder.of a Sn-Cu system to be what noted having heat-resistant cycle nature compared with a Sn-Ag system solder or a solder of a Sn-Sb system, to lower the melting point of a Sn-Cu system solder, and to lessen heat damage to electronic parts at the time of soldering, and to raise [how] a mechanical strength of a Sn-Cu system solder, and completed this invention.

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EXAMPLE

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